

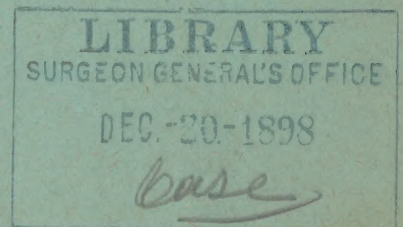
SENN (N.J.)

The Modern Treatment of Gunshot Wounds in Military Practice.

BY N. SENN, M.D., PH.D., LL.D.

LIEUTENANT-COLONEL U. S. VOLUNTEERS, CHIEF OPERATING SURGEON WITH THE ARMY IN THE FIELD.

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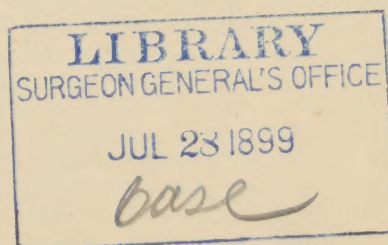
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The Modern Treatment of Gunshot Wounds in Military Practice.

Two important causes are destined to bring about a radical change in the treatment of gunshot wounds as practiced in the war of the rebellion and as will be taught and advised in the Spanish-American and future wars: 1, the modifications which the weapon and projectile have undergone since that time; 2, the introduction into general practice of aseptic and antiseptic surgery. The diminution in the caliber of the bullet, the metallic jacket, the substitution of smokeless for black powder, the greater velocity and power of penetration of the missile, are conditions and influences which must necessarily modify the character of wounds inflicted with the modern weapon. Volumes have been written on this subject by writers in all countries in which the old weapon has been abandoned and the new one introduced. Numerous experiments have been made on cadavers and animals for the purpose of studying the effects of the modern projectile on the tissues with a view of obtaining reliable information as to the changes which will become necessary in the rational treatment of gunshot wounds in modern warfare. Experimental investigation has done much in pointing out some of the changes we may expect to see in the character of gunshot wounds during the present and coming wars, but many of the conclusions drawn from them will have to be modified after we have had an opportunity to study such wounds on a large scale on the battlefield. There can be no question but that the living body and the cadaver represent two entirely different mediums in studying the effects of the modern bullet. From a practical standpoint there remains no doubt as to the following facts, which will be confirmed by future experience in the treatment of gunshot injuries inflicted with the small caliber bullet: 1. Few bullets will be found lodged in the body. 2. Wounds will resemble more closely incised than contused wounds. 3. Range will have more influence in changing the character of the wound. 4. Diminished risk of infection. 5. Dangerous primary hemorrhage will be more, secondary hemorrhage less frequent. 6. More difficult extraction of the bullet. As to the relative number of dead and wounded and the adaptation of the jacketed bullet to become encysted, are subjects on which we can only theorize and conjecture, subjects which can only be definitely settled by an extensive experience. We are better prepared to predict the influence wrought by the recent discoveries and advancements in surgery on the treatment of gunshot wounds and the fate of the wounded. The antiseptic treatment of wounds as taught and practiced by the immortal Lister, and asepsis as developed by the German surgeons with the distinguished Volkmann as their leader, are destined to minimize the remote dangers of gunshot wounds and other open injuries inflicted on the battle-

field. We can safely repeat with the late Professor von Nussbaum, the most enthusiastic follower of Lister: "*The fate of the wounded rests in the hands of the one who applies the first dressing.*" This is the motto that every military surgeon must adopt and carry into effect. To this motto I should like to add a cast-iron rule that should never be transgressed and which, if observed without exception, will guard against one of the most fruitful sources of infection, and that rule should be: *Never probe a bullet wound on the battlefield.* The experience of the past has taught us the wisdom of adopting such a universal rule. As our enemy is armed with the Mauser rifle, the cases will be few where there is any indication for probing wounds, and in those few where the bullet has lodged in the body, exploration should be absolutely prohibited until the patient reaches the field hospital where the facilities for asepsis are at hand and instruments of precision in diagnosis can be employed in locating the missile.

FIRST AID DRESSING.

The idea of rendering first aid to the wounded immediately upon receipt of injury in modern warfare must be abandoned. Alarming hemorrhage from a large vessel of any of the extremities will in many instances be arrested by the patient himself or his nearest comrade by the use of some sort of circular constriction, but the legitimate function of the hospital corps men will begin after the engagement. Desirable as it may appear, attempts at disinfection of the wound or wounds will prove impracticable and useless on the battlefield. Time alone is an important element in contraindicating such a course. Hundreds and thousands may demand attention, to say nothing of the limited facilities for procuring for the wound and its vicinity an aseptic condition. The wisest and safest course to pursue under such circumstances is to make an intelligent use of the first aid dressing package which should be found upon the person of every soldier, officers and men. The average first aid package, the one devised by von Esmarch included, is too cumbersome. A first aid package, to meet the indications for which it is employed, should include: 1, an efficient antiseptic powder; 2, a sufficient quantity of a hygroscopic material to absorb the primary wound secretions and serve as a filter for the wound; 3, a handkerchief or bandage with which to retain the dressing and in case of necessity to be used in constructing a Spanish windlass; 4, safety pins. A few years ago I devised such a package. It contains about a teaspoonful of a powder composed of four parts of boracic acid, one part of salicylic acid, about one drachm of absorbent cotton, a piece of sterile gauze forty inches square and a number of safety

pins. The powder is lodged in the center of the cotton compress and is to be applied directly to the wound when the package is used. The package when compressed is small and wrapped in gutta percha. Every soldier of the Illinois volunteers carries such a package and is conversant with the manner in which it should be employed. The piece of gauze can be readily transformed into a Mayer triangular bandage and serves as an excellent substitute for Esmarch's bandage, which is heavier and requires much more space. The figures printed on Esmarch's bandage are useful for instruction but absolutely without value on the battlefield. In rendering first aid the injured part should be divested of clothing with as little disturbance of the wound as possible. Instead of removing the clothing it is much better to make free use of scissors and knife in gaining access to the wound. If two wounds are found, both must receive the same attention and care in protecting them against infection. I have used the antiseptic powder which I have referred to on a very large scale and can speak in positive terms of its potent antiseptic properties. It resembles in its effects on the tissues Thiersch's solution, being odorless, non-irritating and non-toxic. It forms with the cotton and primary wound secretions a crust which effectually seals the wound. In the absence of grave symptoms such as hemorrhage, this dressing should not be disturbed until the patient reaches the field hospital, and in many cases healing of the wound will take place without further interference. The immobilization of the injured part, particularly in cases of compound fracture of the extremities, constitutes an important part of the manifest duties of those who render first aid to the wounded. In all large engagements the supply of mechanical supports carried by the men of the hospital corps will be exhausted long before all of the wounded have received attention. Splints must be improvised. Rifles, sabers, bayonets, bark, branches of trees, shrubs, etc., the chest in fractures of the upper extremity, the opposite limb in fractures of the thigh or leg, will have to be utilized in procuring rest for the injured limb in transporting patients from the line of battle to the first dressing station. It is here that the surgeons will supplement or improve the work done by the litter bearers and hospital corps. It is for the purpose of doing away with the necessity of using splints that a German military surgeon has recently devised a litter on the plan of a double inclined plane for the lower extremities, a description of which he gave before the military section of the International Medical Congress held in Moscow last summer. In the absence of a litter of such special construction the same object is attained by securing the same position for the injured limb by a roll made of a blanket, clothing, knapsack, drum, straw, etc. It is my opinion that the transportation of the wounded suffering from a fracture of the lower extremity can be done with less pain and with greater security against additional injuries if the fractured limb is placed in a flexed than a straight position. If this statement is found to be correct by future observations the manner of dressing such cases must undergo a material change in the future. The manner of handling, carrying and conveying patients from the field to the hospital, suffering from fracture of the lower extremity, is a subject of great importance to those who have in charge the instruction of the hospital corps and company bearers.

ARREST OF HEMORRHAGE ON THE FIELD.

Life will be placed in jeopardy and deaths will occur more frequently from internal than external hemorrhage; in the treatment of the former little can be done in the field, and the latter class will come more frequently under the care of more professional men than surgeons. Ligation of arteries in the field will prove impracticable in most instances. The company bearers and hospital corps men should be fully instructed in the details of the various hemostatic resources applicable in emergency work. Elevation of the injured part, hyperflexion, digital compression and antiseptic tamponade are some of the measures employed which can be entrusted to intelligent and well instructed laymen in arresting hemorrhage. Some form of circular constriction will, however, most frequently be relied upon in arresting hemorrhage complicating gunshot wounds of the extremities. The advantages and dangers attending this method of arresting hemorrhage must be made a prominent feature in giving instructions on first aid. The technique of the procedure, whether it consists in the use of the typical Esmarch's elastic constrictor, a pair of suspenders or the Spanish windlass, must be fully explained and demonstrated on the living subject. The fact must be impressed that it is of great importance to render the limb that is to be constricted comparatively bloodless by elevation before the constrictor is applied. The next most important advice to be carried into effect in the use of circular constriction is to *constrict quickly and with sufficient firmness to interrupt at once and completely both the arterial and venous circulation*. A question of immense and far reaching importance, and one which has not as yet been definitely answered is: How long is it safe to continue the constriction? There must be, and there is, a limit as to length of time it is safe to exclude blood supply from living tissues. Although cases have been reported in which elastic constriction was continued for three to twelve hours without any serious immediate or remote consequences following, yet the consensus of opinion among surgeons, I am sure, at the present time would be opposed to excluding the blood supply from an entire limb, the seat of a gunshot injury, for a longer time than three to four hours. The danger of gangrene is always greater in constricting an injured than a healthy limb. A number of years ago I made an extended series of experiments on dogs to determine if possible, the maximum length of time it would be safe to continue elastic constriction. The limb was invariably constricted near its base. The time varied from an hour and a half to twenty-seven hours. In a number of cases temporary incompetence of the muscles and temporary paralysis followed when constriction was continued beyond four hours, but the degree of functional disturbance was not always proportionate to the length of time. In only one instance did gangrene occur, and in this case constriction was continued for seventeen hours, while the maximum time was twenty-seven hours. This subject is of special interest to the military surgeon, as from the very nature of things if circular constriction is resorted to as a hemostatic agent on the battlefield a considerable length of time must necessarily intervene before the wounded reach the first dressing station or field hospital, where it is removed and hemorrhage arrested by direct and permanent hemostatic measures. I should consider it dangerous to extend the time beyond from three to six hours, and should

insist that within this limit of time the patient should be placed in charge of a surgeon fully equipped to substitute for it the ligature, aseptic tamponade or some other direct hemostatic agent.

LOCATING, FINDING AND EXTRACTING BULLETS.

The new weapon will minimize the surgeon's work in locating, finding and removing bullets. In the vast majority of cases requiring surgical treatment two wounds will be found, the wound of entrance and exit marking the location and direction of the tubular wound made by the bullet. The cases in which the jacketed bullet will be found in the body indicated by the existence of only one wound will be exceptional. During my visit to the military hospitals in Greece last summer I found a good many wounds made by the small caliber projectile, but only in two cases could I obtain authentic information to the effect that the bullet was found in the tissues of the body and was removed by operative procedure. In the military hospitals in Turkey I found numerous cases in which the old-fashioned large caliber lead bullet used by the Greeks have been removed by operation or remained lodged in the body. The search for bullets in modern warfare, if made at all, will be reserved until the patient has reached the field hospital, when the surgeons will have at their disposal the necessary instrument for making an accurate diagnosis, and the essential facilities for making operations under the strictest aseptic and antiseptic precautions. Before using the finger or probe in exploration for a bullet the wound and the surface for a considerable distance around it should be thoroughly disinfected to guard against all possibility of infecting the wound during the examination or attempts at removal of the bullet, should such a course be deemed advisable after the completion of the examination. One of the most important rules to be followed in locating a bullet in the body is to place the patient and the part injured as nearly as possible in the same position as when occupied the moment the injury was received. The truth of this statement was well exemplified in the case of Gen. Hancock. A number of surgeons of good repute had made repeated attempts to find the bullet by probing but failed. At last he availed himself of the services of Dr. Reade, the present Surgeon-General of Pennsylvania, who placed the General in the same position he occupied in the saddle, and the first attempt to locate the bullet proved successful. The metal clad bullet has to a certain extent rendered the famous Nélaton probe obsolete. However, leaden bullets will be used to a greater or less extent by certain branches of the military force, and the porcelain tip will occasionally prove of service. The great objection to Nélaton's bullet probe is the size of the porcelain tip. *The end of the probe should correspond approximately in size to the caliber of the tubular wound.* By using an instrument constructed on this principle the danger of making false passages is greatly reduced. I have had a bullet probe constructed by Truax, Greene & Co., with two porcelain tips, one at each end rivited to the end of the silver probe, one 22 and the other 38 caliber. In parts of the body composed of deep muscular planes and layers of fascia it is often found absolutely impossible to follow the track of the bullet with any kind of probe. It is in such cases, when it is deemed prudent, from the symptoms presented and the probable location of the bullet, to explore the track that the surgeon will take

advantage of the use of the knife in dilating the track, using the probe step for step as a guide. The use of the X-ray will prove of the greatest value in all future attempts to locate bullets. In order to locate the bullet with sufficient accuracy to enable the surgeon to determine the propriety of an operation for its removal, and to guide him safely in his work photographs from at least two directions will have to be taken. Every field and general hospital should be supplied with an X-ray apparatus, and in all difficult cases this, one of the most recent diagnostic inventions, should be made use of before undertaking an operation, and in preference to repeated recourse to the probe. The famous old-fashioned American bullet forceps has lost its distinction in military surgery by the introduction of the metal clad bullet. The bullet forceps which I show you I devised a few years ago. It is so constructed that it serves at the same time as a useful bullet probe. The grip of the instrument upon any metallic bullet regardless of its caliber is firm, the bullet once grasped can be extracted without difficulty, as slipping of the instrument is almost an impossibility. It seems to me that when a small caliber bullet lodged in an important anatomic locality, difficult of approach and not giving rise to any serious symptoms, it should be allowed to remain with the hope that it may become encysted without causing any remote serious consequences. Such a conservative course in well selected cases will unquestionably yield better results than the too common routine practice to extract the bullet at all hazards.

GUNSHOT WOUNDS OF THE EXTREMITIES.

Besides the ordinary treatment of gunshot wounds regardless of the anatomic location of the injury, bullet wounds of the extremities, where complicated by fracture or joint injury, present to the surgeon special clinical features of great importance. Injuries of soft tissues not implicating important vessels and nerves, under modern treatment, should heal in a short time under the first dressing with little or no functional impairment. The existence of a gunshot fracture regardless of the extent of bone injury no longer furnishes a legitimate indication for a primary amputation. Such injuries under appropriate aseptic and mechanical treatment are amenable to a satisfactory repair in the course of time. They are the cases that tax the ingenuity of the surgeon in applying and maintaining the necessary mechanical support until the fracture heals by bony consolidation with the limb in a satisfactory useful position. In gunshot fractures of the femur extension and immobilization will now, as it has for a long time, constitute the generally accepted treatment. A determined, strong protest must be made against the unnecessary removal of detached and partially detached fragments of bone. If the wound remains aseptic the loose fragments of bone will not only retain their vitality but will take an important part in the restoration of the continuity of the bone and add materially to the functional result. Débridement, more or less extensive, only becomes necessary and should be performed in case the wound becomes infected. In such an event the loose infected fragments of bone should be promptly removed, free tubular drainage established, and the wound throughout subjected to thorough disinfection. If the ordinary measures should fail, continued irrigation with a saturated solution of acetate of aluminium will very often bring about the desired

results and obviate the necessity of an amputation. Fixation and suspension in such cases will not only procure comfort for the patient but will answer an excellent purpose in securing and maintaining coaptations and in facilitating drainage and irrigation. As soon as the fracture has united with sufficient firmness to render extension superfluous, the limb should be immobilized in a circular plaster of Paris splint, extending from base of toes to the groin, and in high fractures including the pelvis, after which the patient can be permitted to walk about with the aid of crutches. In gunshot fractures of the leg early immobilization in a circular plastic splint is to be advised and yields the most gratifying results. Watchful control of patients suffering from such injuries and treated by the use of the plaster of Paris bandage is essential in guarding against disastrous complications and in obtaining satisfactory functional results. Gunshot injuries of any of the large joints are now within the range of successful conservative treatment. I have seen in the military hospitals, both in Greece and Turkey, soon after the close of the war, gunshot wounds of the hip, knee, ankle, shoulder, elbow and wrist joints, not only recover without any operative interference whatever, but in many of the cases a fair degree of motion and good use of the limb rewarded the conservative treatment. The indications for primary amputation of a limb, or part of a limb, should at present be restricted to cases in which the nutrition is suspended or seriously threatened by the coexistence of vascular lesions incompatible with the vitality of the tissues at and below the seat of injury. In cases of doubt the soldier is entitled to the benefit of the same, and the conservative treatment should be carried to its ultimate limits until the appearance of complications demonstrate its futility and dictate the propriety of resorting to a mutilating operation. It is always more creditable to the surgeon to save a limb than to remove it, and the soldier is entitled to the benefit of conservative surgery as much as the civilian, and the plan of the military surgeon of the future should and will be to limit more and more the indications for amputations.

GUNSHOT WOUNDS OF THE SKULL.

It is my intention to limit my remarks under this heading to penetrating gunshot wounds of the skull. The few cases of this class of injuries that will come under the observation of the military surgeon will invariably require operative interference, provided it holds out any encouragement whatever of saving life. In case a bullet has passed through the skull and its contents the entire scalp should be thoroughly shaved and disinfected. The wound of entrance must be enlarged sufficiently to expose the perforation freely, which is then enlarged with chisel, DeVilbiss or rongeur forceps sufficiently to enable the surgeon to remove the loose spicula of bone, which are frequently found some distance in the brain. With a long eyed probe a strip of iodoform gauze large enough to loosely pack the tubular visceral wound should be inserted from the wound of entrance to the wound of exit, and the rough gauze drain made to project a few inches beyond the surface of each wound. Thorough capillary drainage of this kind will prevent accumulation of primary wound secretion in the interior of the skull, and will be of value in arresting capillary hemorrhage. A large hygroscopic dressing enveloping the entire scalp and covering both wounds, con-

stitutes the dressing and must be held in place by a few turns of plaster of Paris bandage. The drain must be allowed to remain until the danger of infection is passed, when it is to be removed gradually by shortening it every day or two. In case the bullet should be found lodged in the interior of the skull the wound of entrance must be treated in the same manner and the bullet located by the careful use of Flubrer's aluminium probe. A counter opening may become necessary in removing the bullet if it has reached the opposite side of the skull or when it has become deflected or arrested in its course near the surface of the brain, in case the locality in which it has become lodged warrants operative intervention. In all visceral injuries of the contents of the skull resulting from gunshot wounds capillary or tubular drainage or a combination of the two is indicated and should be continued until there is no further danger of infection, hemorrhage or accumulation of wound products, when the drain is to be gradually removed. The value of the X-ray in locating bullets in the interior of the cranium has as yet not been definitely ascertained.

GUNSHOT WOUNDS OF THE CHEST.

Penetrating gunshot wounds of the chest are attended by an enormous mortality owing to the physiologic importance of the organs which it contains. Visceral wounds of the heart and large blood vessels usually result in death in a few moments from acute anemia. Hemorrhage into the pleural cavity and into the large bronchial tubes interferes mechanically with the respiratory functions and frequently proves fatal in a short time and if the patient recovers from its immediate effects life is placed in danger by complications which so often are caused by the hemothorax. The accumulation of such a large quantity of blood in the pleural cavity is not incompatible with a speedy recovery, as when the blood is aseptic its removal by absorption is accomplished in a short time.

Experience during the War of the Rebellion proved that in gunshot wounds of the chest the chances for life were much better if the bullet passed through the chest than if it remained lodged in the body. I saw a number of soldiers of the Graeco-Turkish war that had been shot through the chest convalescent and in fair health a few weeks after the injury was inflicted. We have made little progress in the treatment of penetrating wounds of the chest. Direct operative treatment of visceral wounds of the heart and lungs is always attended by imminent risk to life from pulmonary collapse. This source of danger stands in the way of direct treatment of visceral wounds of the chest. Hemorrhage from wounds of the lung is often corrected spontaneously by the accumulation of blood in the cavity of the chest, causing temporary pulmonary collapse and tamponade of the tubular visceral wound by the formation of a blood clot. Free incision of the chest wall has been strongly advocated by several French surgeons in cases of penetrating gunshot wounds of the chest with a view of arresting hemorrhage by ligature, tamponade or the use of the cautery, but the profession on the whole, for good reasons, is opposed to such heroic treatment. Unless the source of hemorrhage is one of the intercostal or the internal mammary artery it is advisable to rely on nature's resources in arresting the bleeding. Hemorrhage from the intercostal arteries can be effectually checked by tamponade, using for this

purpose an hour glass shaped tampon of iodoform gauze. Rest in the recumbent position, with the chest slightly elevated, is essential in aiding spontaneous arrest of hemorrhage and in the prevention of complications. A rise in the temperature during the first forty-eight hours is no indication of the existence of sepsis, as with few exceptions it indicates a febrile disturbance, caused by the absorption of fibrin ferment, the so-called fermentation fever. Should later symptoms set in suggestive of septic infection, aspiration should be promptly resorted to and if not followed by speedy improvement no time should be lost in subjecting the patient to the same medical treatment as advised and practiced for empyema, that is, rib resection, free incision and drainage. The production of an artificial pneumothorax or hydrothorax by the introduction into the pleural cavity on the injured side of a non-toxic gas or filtered atmospheric air or sterilized water or non-toxic antiseptic solutions has not proved satisfactory in the treatment of intrathoracic traumatic hemorrhage. From what has been said it is clear that the best treatment in penetrating gunshot wounds of the chest consists in hermetically sealing the wound of entrance and exit, if such exists, under strict aseptic precautions and watch for and treat subsequent complications as they present themselves.

GUNSHOT WOUNDS OF THE ABDOMEN.

The greater part of this paper will be devoted to this subject, as recent discoveries and improvements in surgery have done more for the successful treatment of visceral wounds of the abdominal organs than the injuries of any of the organs contained in the remaining large cavities of the body. The triumphs that have signaled the practice of civilian surgeons in the operative treatment of intra-abdominal injuries must be repeated on the battlefield. I look hopefully for many successful results in the operative treatment of gunshot wounds in military practice. I will in this connection limit my remarks to penetrating wounds, taking it for granted that when patients suffering from abdominal wounds are brought to the field hospitals the surgeons in charge will consider it their imperative duty to make a positive distinction between penetrating and non-penetrating wounds before assuming the responsibility of opening the abdomen. In the discussion of penetrating wounds of the abdomen I shall quote freely from the forthcoming third edition of the American Textbook of Surgery from the chapter which treats of this subject. Sword, bayonet and other stab wounds will diminish in frequency with the development of modern scientific warfare. The penetrating wounds of the abdomen that will come under the observation of the military surgeon will with few exceptions be wounds inflicted with the modern small caliber projectile. The visceral wounds, the wound of entrance and exit will be small, too small for digital exploration. It is perhaps superfluous to make the statement here that *a penetrating wound of the abdomen should never be probed either for diagnostic or therapeutic purposes*. If any doubt exists as to whether or not the bullet has entered the abdominal cavity it is far better and safer to dilate the track by the use of the knife, relying on the probe as a guide, than to work in the dark with the probe and by doing so increasing the possibilities of infecting the peritoneal cavity. Quite recently the assertion has been made by several prominent surgeons that laparotomy should

be performed in all cases where it can be shown that penetration has occurred. It must, however, be admitted that, in the absence of serious visceral lesions, penetrating wounds of the abdomen are injuries from which the patients are very likely to recover without operative treatment, and that when such patients are subjected to laparotomy death may occur solely in consequence of the operation. It is undoubtedly true that in most cases of spontaneous recovery after penetrating gunshot wound of the abdomen the favorable termination has been due to the absence of serious visceral lesions, which some hold to be invariably present in such cases. A number of years ago I made a series of experiments on the cadaver for the purpose of demonstrating that occasionally a bullet can traverse the abdominal cavity in certain directions without producing a visceral wound that would warrant a laparotomy. The cadaver, a marasmic adult male was placed in the erect position against a wall and the shooting was done with a 38 caliber rifle at a distance of 30 feet. The bullet was fired in every instance in an antero-posterior direction and invariably passed through the body. Sixteen shots were fired and examination of the abdominal cavity carefully made by following the track of each bullet, showed that four of the bullets traversed the abdominal cavity without injuring the stomach or intestines or any of the large abdominal vessels. In each of these four experiments the bullet entered the abdomen at or a little above the umbilical level. In all experiments in which the bullet entered below the umbilical level intestinal perforations were found. Absence of visceral lesions has been also demonstrated during an operation or at the postmortem. During the Graeco-Turkish war several cases of gunshot wound of the abdomen recovered under a conservative plan of treatment. In nearly all of these cases the bullet entered the abdomen above the umbilicus, the most favorable location for the escape of intestines from the missile, the patient being in a standing position.

In two out of sixteen cases of penetrating gunshot wounds of the abdomen which came under the observation of the writer the absence of visceral injuries of the gastro-intestinal canal was demonstrated by the use of the hydrogen gas-test, and both of these patients recovered without resort to laparotomy. Clinical experience and the result of experiment show conclusively that laparotomy should not be performed simply because a bullet has entered the abdominal cavity, but that its performance should be limited to the treatment of intra-abdominal lesions which, without operative interference, would tend to destroy life. A bullet which passes through the lower part of the abdomen from side to side or obliquely is almost sure to produce from four to fourteen perforations of the intestines, while absence of dangerous visceral complications may be inferred with some degree of probability if it crosses the abdominal cavity in an antero-posterior direction at, or a little above, the umbilical level.

SYMPTOMS.

The general symptoms in cases of penetrating gunshot wounds of the abdomen, with the exception of those due to profuse hemorrhage, furnish very little information in reference to the existence or absence of visceral complications. Severe shock may attend a single non-penetrating wound, and it may be wanting, or at least slight, in cases of multiple perforation

of the intestines. It is not an uncommon occurrence for a patient who has received a penetrating wound of the abdomen to walk several blocks, or even a number of miles, without a great deal of suffering and without showing any symptoms of shock, and yet for a number of intestinal perforations to be revealed at a subsequent operation or autopsy. Vomiting occurs with equal frequency in parietal wounds and in simple penetrating wounds as when the viscera have been injured. Vomiting of blood points to the existence of a wound of the stomach.

Pallor is present in all penetrating wounds of the abdomen, soon after the receipt of the injury, and it is only more pronounced when produced, at least in part, by sudden and severe hemorrhage. Pain is very unreliable and often misleading symptom, as it may be moderate or almost completely absent soon after the injury has been inflicted, even when multiple perforations are present. The pulse at first is slow and compressible in all cases, and nothing characteristic in its qualities is observed even if the stomach or intestines have been wounded. Hemorrhage caused by wounds of any of the large organs, as the spleen, liver or kidneys, gives rise to progressive acute anemia, small rapid pulse, cold clammy perspiration, dilated pupils, yawning, vomiting, and in extreme cases, syncope and convulsions. The local symptoms are of no more value in determining the existence of visceral injuries in penetrating wounds of the abdomen than are the general symptoms which have just been enumerated. External hemorrhage is slight or entirely wanting, unless an artery or vein in the abdominal wall has been injured. The bleeding from visceral wounds gives rise to accumulations of blood in the peritoneal cavity, occult or internal hemorrhage; this can be recognized by physical signs which denote the presence of fluid in the free abdominal cavity and by general symptoms indicating progressive anemia; increasing pallor of the face and of the visible mucous membranes, small feeble pulse, superficial sighing, respiration and dilated pupils. Wounds of the stomach often occasion hemorrhage into this organ and hematemesis. Blood in the stools seldom follows hemorrhage into the bowels from intestinal wounds sufficiently early to be of any diagnostic value.

Circumscribed emphysema in the tissues around the track made by a bullet has been regarded as an important sign of the existence of intestinal perforation. This symptom is misleading and absolutely devoid of diagnostic value, as this condition has frequently been observed in non-penetrating wounds of the abdominal wall, resulting from the entrance of air into the loose connective tissue, or later by gas formation as one of the results of putrefactive infection. The accumulation of any considerable quantity of gas in the peritoneal cavity sometimes can be recognized by the disappearance of the normal liver dullness, caused by the presence of gas between the surface of the liver and the chest wall. This condition has been sought for in cases of perforating wounds of the abdomen as a diagnostic sign, and if found has been taken as a sure indication of the existence of visceral wounds of the gastro-intestinal canal. This is not, however, always the case. Adhesions between the surface of the liver and chest wall may have existed before the injury was received, or the amount of gas present may be insufficient to give rise to this sign. The escape of the contents of the wounded

stomach or intestines through the external wound, is a rare occurrence, and is possible only when the external wound is sufficiently large and straight and when it corresponds with the location of the visceral wound, or in the event of pre-existing adhesions between the abdominal wall and the injured portion of the gastro-intestinal canal. External extravasation occurs more frequently in wounds of the large than the small intestine. When this symptom is present it is conclusive proof of the existence of a visceral wound of the gastro-intestinal canal and the character of the extravasation will furnish reliable information as to the anatomic location of the visceral injury. With the exception of the last mentioned symptom and the indications pointing to the necessity of arresting internal hemorrhage, there is nothing about the local or general symptoms in cases of penetrating gunshot wounds of the abdomen that would enable the surgeon to decide with any degree of certainty soon after the injury was received, whether or not visceral injuries existed and consequently, whether laparotomy should or should not be performed.

DIAGNOSIS.

If a gunshot wound has penetrated the abdominal cavity and the general symptoms and local signs lead us to suspicion the existence of dangerous internal hemorrhage, *no time should be lost in further efforts to make an accurate anatomical diagnosis*, as sufficient evidence has been obtained to warrant a laparotomy for the purpose of preventing death from hemorrhage by the direct surgical treatment of the visceral injuries. If no such urgent indication presents itself it is desirable that the existence of visceral lesions demanding surgical treatment should be ascertained before the patient is subjected to the additional risk incident to a laparotomy, since a simple penetrating wound of the abdomen is an injury from which the majority of patients recover without operative treatment, and since visceral wounds of the gastro-intestinal canal are attended by such frightful mortality without surgical interference, the practical value and importance of a correct diagnosis before deciding upon a definite plan of treatment become obvious. It is apparent that if some reliable diagnostic test could be applied in cases of penetrating wounds of the abdomen which would indicate to the surgeon the presence or absence of visceral lesions of the gastro-intestinal canal, the indications for aggressive or conservative treatment would become clear. The writer has shown by his experiments on animals, and later by his clinical experience in the treatment of a number of cases of gunshot wounds of the abdomen that rectal insufflations of hydrogen gas can be relied upon in demonstrating the existence of perforations of the gastro-intestinal canal before opening the abdomen. He has shown conclusively that if the abdominal muscles are completely relaxed under the influence of a general anesthetic, hydrogen gas or filtered air can under safe pressure be forced from the anus to the mouth if no perforations exist, and if such are present the gas will escape into the peritoneal cavity, where its presence can be readily detected by the physical signs characteristic of a free tympanites or by its escape through the external opening. Theoretical objections have been made against this diagnostic test on the ground that it occasionally fails in demonstrating the existence of a perforation, and that it is instrumental in causing

fecal extravasation. In reply to this I must say that it has never failed in my hands in making by its aid a correct diagnosis, and the fallacy of the second objection I have shown repeatedly by experiments on animals. Hydrogen gas is a non-toxic substance, endowed with valuable inhibitory antiseptic properties, and is absorbed from all the larger serous cavities and connective tissue within a few hours. Pure zinc and sulphuric acid should be used in generating the gas, which is collected in a rubber balloon holding at least four gallons. The rubber balloon used for this purpose is square in shape and is connected with the rectal tip by means of a rubber tube six feet in length and supplied with a stop-cock near its proximal end. In applying the test an assistant presses the margin of the anus against the rectal tip, so as to prevent the escape of the gas, while another assistant forces the gas along the intestinal tube by pressing or sitting on the rubber balloon. The gas passes through the ileocecal valve under a pressure of two and a half pounds to the square inch and is announced by a distinct gurgling sound, which can always be distinctly heard by applying the ear or stethoscope over that region. If the rectum or colon has been perforated the gas will not reach the small intestine, as it will escape into the peritoneal cavity under less pressure than is required in rendering the ileocecal valve incompetent. As soon as the gas reaches a perforation large enough to permit its escape it will enter the peritoneal cavity and escape through the external wound if this has been freely laid open down to the peritoneum. If the external wound is in a location which points to injury of the stomach, this organ should be insufflated through a rubber stomach-tube, and if this test proves negative it is to be followed by rectal insufflation. It is impossible to inflate the intestines to any extent from the stomach.

TREATMENT.

The propriety of surgical interference in cases of penetrating gunshot wounds of the abdomen will depend upon one of three things:

1. General conditions of the patient.
2. Dangerous internal hemorrhage.
3. Wounds of the stomach or intestines large enough to permit extravasation. If the patient is pulseless and presents other indications of approaching death, operation is unjustifiable, as it would only hasten the end and bring reproach upon surgery and undermine the confidence in the life-saving value of the operation among the troops. Dangerous internal hemorrhage that will come to the notice of military surgeons in gunshot wounds of the abdomen will be the cases in which the vascular organs of the abdomen, the liver and spleen, or some of the larger vessels of the mesentery or omentum have been injured. Delay in such cases is dangerous. The abdomen should be opened and the hemorrhage arrested. The symptoms are apt to be unusually severe if the hemorrhage is sudden, progressive, if the loss of blood is gradual. In the latter case it may be prudent to watch the case for some time for more pressing indications, as it is well known that spontaneous arrest of hemorrhage may occur and large quantities of aseptic blood is removed from the peritoneal cavity in a short time. Visceral lesion of the gastro-intestinal canal large enough to permit extravasation are, with very few exceptions, mortal wounds, the existence of which can leave no doubt in the mind of the

surgeon to resort promptly to abdominal section as offering the only chance to save life.

PREPARATION OF PATIENT.

A patient suffering from a penetrating gunshot wound of the abdomen should be properly prepared before he is subjected to laparotomy. If the stomach is filled with food, a salt water emetic should be given for the purpose of emptying its contents, or better still, this can be done by the use of the stomach siphon tube. The rectum and colon must be emptied by a copious enema of warm water, to which may be added a tablespoonful of common salt. The unloading of the gastro-intestinal canal will not only facilitate the operation but will have a favorable influence in securing rest for the injured part. A hypodermatic injection of gr. 1/4 of morphin and gr. 1/30 of strychnia should be given shortly before the anesthetic is administered, as these remedies in the doses specified assist the action of the anesthetic, secure rest for the intestines, and sustains the action of the heart. If the patient is much prostrated two ounces of whisky diluted with four ounces of warm water should be given by the rectum. The whole abdomen should be thoroughly disinfected. Before and during the operation the use of external dry heat will do much in preventing shock and in aiding the peripheral circulation. Compresses, towels and several gallons of warm normal solution of salt must be provided. The operator should do the work with as little assistance and as few instruments as possible, as the danger of infection in emergency work is apt to be proportionate with the number of assistants employed and number of instruments used. Hands, instruments, suturing material, in fact everything that is to be brought in contact with the wound, must be sterilized. In military surgery silk will have the preference over catgut. A hospital tent with a floor will be an admirable operating room in all semi-tropical climates. Anesthesia should be commenced with chloroform until the patient is under its full influence, when it should be continued with ether.

INCISION.

In the majority of cases the median incision should be made, as it affords advantages which give it the preference. It should always be selected in cases of gunshot wounds of the stomach, and where the wound of entrance is located near the median line. A median incision affords most ready access in the treatment of wounds of the small intestine. If the insufflation test is used, it will prove sometimes of value in deciding upon the location of the incision. If in gunshot wounds of the upper portion of the abdomen, direct inflation of the stomach through an elastic tube reveals the existence of perforation of this organ, the median incision should be selected. If rectal insufflation yields a positive result before the gas has passed the ileocecal valve, the incision should be made over the wounded portion of the colon, which is usually indicated by the course of the bullet. A wound in the transverse colon can be found and dealt with most effectually through a high median incision, perforation of the cecum or of the ascending colon calls for a lateral incision directly over the wounded organ, while a lateral incision on the left side is indicated if from the direction of the bullet it is evident or probable that the colon below the splenic flexure is the seat of the visceral injury. Laparotomy performed for the arrest of hemorrhage should always be done by mak-

ing a long median incision, which will afford the most direct access to the different sources of hemorrhage. Very often it will be advisable to make the incision in the line of the wound of entrance, more especially in cases where a lateral incision is indicated from the location of the wound from the course of the bullet, and perhaps from the results obtained by the insufflation test.

ARREST OF HEMORRHAGE.

In opening the abdomen in the treatment of internal hemorrhage the surgeon undertakes a task, the gravity of which it is impossible to foretell. To do the work quietly and well he must be perfectly familiar with the anatomy of the abdominal organs, their source of blood supply, and must have full knowledge of all hemostatic resources, the indication for their selection and details of application. Profuse intra-abdominal hemorrhage resulting from penetrating gunshot wounds of the abdomen is more frequently of parenchymatous and venous than arterial origin. Wounds of the liver, spleen, kidneys and mesentery give rise to profuse and often fatal hemorrhage. After opening the peritoneal cavity it is often very difficult to find the bleeding points, as the blood accumulates as rapidly as it is sponged out, and it becomes necessary to resort to special means in order to arrest profuse bleeding sufficiently to find the source of hemorrhage. One of two means should be employed: 1, intra-abdominal digital compression of the aorta; 2, packing the abdominal cavity with a number of large sponges or gauze compresses. Intra-abdominal compression of the aorta below the diaphragm can be readily made by an assistant introducing his hand through the abdominal incision, which in such a case must be larger than under ordinary circumstances. Compression made in this manner will promptly arrest the hemorrhage from any of the abdominal organs for a sufficient length of time to enable the surgeon to find the source of hemorrhage, and carry out the necessary treatment for its permanent arrest.

Hemorrhage from a perforated kidney may demand a nephrectomy, if it does not yield to tamponade. If the tampon is used an incision in the lumbar region must be made for the removal of the tampon and the parietal peritoneum should be sutured, so as to exclude the peritoneal cavity from the renal wounds. Wounds of the liver are sutured with catgut, cauterized with the actual cautery, or tamponaded with a long strip of iodoform or a typical Mikulicz tampon; in either case the gauze is to be brought out of the wound and utilized as a drain.

A wound of the spleen, if the hemorrhage does not yield to ligature, suturing or tamponade, necessitates splenectomy; very troublesome hemorrhage is often met with in wounds of the mesentery. When multiple wounds of the mesentery, and visceral wounds of the stomach or intestines are the cause of hemorrhage, it is a good plan to pack the abdominal cavity with a number of large sponges, napkins or compresses of gauze, to each of which a long strip of gauze is securely tied, these strips being allowed to hang out of the wound in order that none of the sponges or compresses may be lost or forgotten in the abdominal cavity after the completion of the operation. The sponges or compresses make sufficient pressure to arrest parenchymatous oozing as well as venous hemorrhage, if they are placed at different points against the mesentery and between the intestinal coils. The sponges

are removed one by one from below upward, and the bleeding points secured as fast as they are uncovered. The ligation of mesenteric and omental vessels, both arteries and veins, should be done by applying the ligature *en masse*. A round needle or Thornton's curved hemostatic forceps are the most useful instruments for this purpose. Catgut, as a rule, should not be relied upon in tying a mesenteric vessel, as it is greatly inferior to fine silk.

If hemorrhage is profuse this must be attended to before anything is done in the way of binding and suturing the visceral wounds. Troublesome hemorrhage from a large visceral wound of the stomach or intestines is best controlled by hemming the margin of the wound with catgut or fine silk. In hemorrhage from localities not accessible to ligation and not amenable to tamponade, pressure forceps are applied and allowed to remain for twenty-four or forty-eight hours. When used in this manner the instrument must be long enough to be brought out of the wound, and is then incorporated in the dressing. For the purpose of facilitating the binding and removal of the instrument a strip of gauze is tied to the handle.

SEARCH FOR PERFORATIONS.

A number of cases have been recorded, and I am sure many more have occurred, in which laparotomy was performed, one or more perforations sutured, and the postmortem showed that a perforation was overlooked, death resulting from extravasation and diffuse septic peritonitis. Such experiences are by no means limited to the practice of novitiates, but have occurred to men of large experience and in well equipped first class hospitals. The handling of the entire length of the gastro-intestinal canal in search for perforations requires time, adds to the shock of the injury and operation, and even if done by experts and with the utmost care, a perforation may escape the attention of the operator and become the sole cause of death. If the surgeon adopts this plan of detecting the perforations the work should be done systematically. The ileocecal region is the best landmark in beginning the search. From here the small intestine is traced in an upward direction, examining loop after loop and returning the intestine as soon as examined so as to avoid extensive eventration, which adds greatly to the danger of the operation. The large intestine is traced from the ileocecal region downward. In one of my cases a perforation of the rectum was found low down in the pelvis and certainly would have been overlooked if I had not used the inflation test, which promptly revealed not only its existence but also its exact location. If the air or gas test has been employed with a positive result before the abdomen was opened there will be no difficulty experienced in finding the first opening. If the stomach was inflated directly through an elastic tube, and the test has shown the presence of a perforation, a median incision is made from the tip of the ensiform cartilage to the umbilicus and the stomach is drawn forward into the wound. If no perforation is found in the anterior wall, the insufflation is repeated, and the escaping air or gas will direct the surgeon to the perforation. Through this perforation the stomach should again be inflated in search for a second and possibly a third perforation. In searching for intestinal wounds by the aid of inflation, further inflation should be suspended as soon as the lowest perforation has been found. If possible, the perforated portion of the

intestine should now be brought forward into the wound, and after emptying the intestine below the perforation as far as possible of its contents, including the gas or air, the bowel is compressed below the perforation by an assistant and the intestine higher up is inflated through the wound. As a matter of course, a perfectly aseptic glass tube should be inserted into the rubber tube in place of the rectal tip. The inflation is now carried as far as the second opening, when the first perforation is sutured, and after disinfection and emptying the intervening portion of its gas the intestine is replaced in the abdominal cavity. Further inflation is now made through the second opening, and if a third one is found the second is sutured, and so on until the entire intestinal canal has been thoroughly subjected to the test. By following this plan extensive eventration is rendered superfluous and the overlooking of a perforation is made impossible, likewise the objection to the test that reduction of the intestines owing to distension with gas or air is overcome if the intervening sections between the perforations are emptied of their contents before suturing the wound.

SUTURING THE PERFORATIONS.

The materials for suturing are an ordinary sewing needle and fine aseptic silk. Catgut should be dispensed with in all intestinal work. Trimming the margins of the visceral wounds is not only superfluous, but absolutely harmful, as it requires a useless expenditure of time and may become an additional source of hemorrhage. The same can be said of the Czerny-Lembert suture. All that is required in the treatment of a visceral wound of the stomach and intestines is to turn the margins of the wound inward and bring into apposition healthy serous surfaces by the continuous or by interrupted sero-muscular sutures, which should always be made to include fibers of Halsted's submucosa. From four to six stitches to an inch will suffice. If possible, wounds of the stomach should be sutured in the direction of the blood vessels, and transverse suturing of the intestine is necessary for the purpose of preventing constriction of the lumen. Defects an inch and a half in length, on the convex side, can be closed in this manner without fear of causing intestinal obstruction, while much smaller defects on the mesenteric side usually necessitate a resection, not only because the vascular supply in the corresponding portion of the intestine would be inadequate, but also because a sufficiently sharp flexion might be produced at the seat of suturing to become the immediate mechanical cause of intestinal obstruction.

ENTERECTOMY.

Enterectomy is often indicated in cases of double perforation and in marginal wounds of the mesenteric border. If in cases of multiple perforations it should become necessary to make a double enterectomy, and the intervening portion of the small intestine is not more than two or three feet in length, it is best to resect the same, as the immediate effect of the single operation will be less severe than that of a double resection with a corresponding double enterorrhaphy. After resection the continuity of the intestinal canal should always be restored by a circular enterorrhaphy, using for this purpose the Czerny-Lembert suture. Strips of sterile gauze are preferable to clamps in preventing extravasation during the operation. The gauze strip is passed through a small buttonhole made with hemostatic forceps in the mesentery near the

intestine and tied with sufficient firmness to prevent escape of intestinal contents.

IRRIGATION OF THE ABDOMINAL CAVITY.

This is necessary only if fecal extravasation or escape of stomach contents has taken place, an accident which, if it has not occurred before the abdomen was opened, should be carefully avoided during the manipulation of the wounded intestines. Flushing the peritoneal cavity with warm sterilized water or normal salt solution not only clears it of infectious material, but acts at the same time as a stimulant to the flagging circulation. The current must be sufficiently strong not only to fill the peritoneal cavity quickly, but to *flush it out*.

After completion of the irrigation, the patient is placed on his side and in this position the fluid contents of the abdominal cavity are poured out. The cavity is then rapidly dried with large sponges wrung out of a weak sublimate solution (1 to 10,000) or Thiersch's solution. Some surgeons have practically abandoned flushing of the abdominal cavity, and rely almost exclusively on sponging in removing pus and extravasated fecal material; others are partial to leaving the physiologic solutions of salt in the cavity, paying no attention to the peritoneal toilette practiced with conscientious care by all surgeons only a few years ago.

DRAINAGE.

To drain or not to drain, is the all absorbing topic among surgeons whose time and attention are largely engaged in abdominal work. I wish to place myself on record as being a strong advocate of drainage in all cases of abdominal surgery in which we have reason to believe that contamination of the peritoneal cavity has taken place by extravasation of contents of the gastro-intestinal canal or pus. In gunshot wounds of the abdomen complicated by visceral injury, the probability that infection has occurred must not be lost sight of, and the only safe course to pursue under such circumstances is to drain when you are in doubt. Cases which require irrigation should always be drained. Other indications for drainage are visceral wounds of the liver and pancreas and the existence of parenchymatous hemorrhage which can not be remedied by any of the different hemostatic measures. A glass drain reaching to the bottom of the pelvis, loosely packed with a strip of iodoform gauze, answers an excellent purpose. Occasionally multiple drains are indicated. The Mikulicz drain is to be depended upon in arresting troublesome surface oozing. Drainage must be suspended at once, or gradually, with the cessation of the primary wound secretion.

SUTURING OF EXTERNAL INCISION.

Incisions through the median line are rapidly closed by one row of silk or silkworm gut sutures, which are placed close together and include all the tissues of the margins of the wound. Incisions made in any other place are to be closed by buried catgut sutures uniting the peritoneum and muscular layer separately, and a superficial row of silkworm gut sutures including all the tissues except the peritoneum. A large hygroscopic compress composed of sterile gauze and absorbent cotton, held in place by broad strips of adhesive plaster, constitutes the proper dressing. The sutures are removed at the end of the second week, and the patient must not be allowed to leave the bed before the expiration of the fourth week. Four weeks in

bed and the wearing of a well fitting abdominal support for three to six months are the most reliable precautions against the occurrence of a post-operative ventral hernia. The drainage opening should be closed with secondary sutures, inserted at the time of operation as soon as the drain is closed, otherwise a ventral hernia will be almost sure to develop in the scar at former site of the drainage tube.

AFTER-TREATMENT.

Absolute rest must be strictly enforced. Opiates must be given in doses sufficient to quiet the peristaltic action of the intestines. Stimulants must be used to counteract the effect of shock and to restore the vigor of the enfeebled peripheral circulation. Absolute diet must be observed for at least forty-eight hours. During this time a mixture of brandy and ice water, in small doses frequently repeated, or iced champagne, is agreeable to the patient, as it quenches thirst, relieves nausea and exerts a favorable influence upon the circulation. If more active stimulation is called for to overcome shock and the effects of hemorrhage, whisky, strychnia, ether, musk, or camphor can be injected subcutaneously or by the rectum, while the peripheral circulation is restored by applying dry heat to the extremities and trunk. The subcutaneous infusion of one to two pints of normal salt solution is an excellent restorative and of special therapeutic efficiency in cases where the vital forces are depressed and life is in danger from the effects of hemorrhage.

Should symptoms of peritonitis set in, a brisk saline cathartic should be given at the end of forty-eight hours, as at this time the intestinal wounds will have become sufficiently united to resist the peristalsis provoked by the cathartic, while the removal of intestinal contents and the absorption of septic material from the peritoneal cavity thus attained are not only the most efficient means of averting a fatal disease, but also of placing the wounds in the most favorable condition for rapid repair. Reopening of the wound and secondary flushing have done little in arresting or limiting septic peritonitis. If the case progresses favorably, liquid food by the stomach can be allowed at the end of the second day, and light solid food at the end of the first week. Under ordinary circumstances no effort is made to move the bowels until the end of the third or fourth day. If early feeding becomes necessary in marasmic or exsan-

guine patients, this can be done by rectal alimentation.

From the contents of the paper the following conclusions can be formulated:

1. In theory and practice military surgery is equivalent in every respect to emergency practice in civil life.

2. The wounded soldier is entitled to the same degree of immunity against infection as persons in civil life suffering from similar injuries.

3. The fate of the wounded rests in the hands of the one who applies the first dressing.

4. The first dressing should be as simple as possible, including an antiseptic powder composed of boracic acid, four parts, salicylic acid, one part, a small compress of cotton, safety pins and a piece of gauze forty inches square.

5. Any attempt to disinfect a wound on the battlefield is impracticable.

6. The first dressing stations and the field hospitals are the legitimate places where the work of the hospital corps and company bearers is to be revised and supplemented. All formal operations must be performed in the field hospitals where the wounded can receive the full benefits of aseptic and antiseptic precautions.

7. Probing for bullets on the battlefield must be absolutely prohibited.

8. Elastic constriction for the arrest of hemorrhage must not be continued for more than four to six hours for fear of causing gangrene.

9. The X-ray will prove a more valuable diagnostic resource than the probe in locating bullets lodged in the body.

10. Gunshot wounds of the extremities must be treated upon the most conservative plan, the indications for primary amputation being limited to cases in which injury of the soft parts, vessels and nerves suspend or seriously threaten the nutrition of the limb below the seat of injury.

11. Operative interference is indicated in all penetrating gunshot wounds of the skull.

12. Gunshot wounds of the chest should be treated by hermetically sealing the wounds under the strictest aseptic precautions.

13. Laparotomy in penetrating gunshot wounds of the abdomen is indicated in all cases where life is threatened by hemorrhage of visceral wounds and the general condition of the patient is such as to sustain the expectation that he will survive the immediate effects of the operation.

